POSSIBILITIES AND LIMITATIONS OF BRAIN SURGERY, WITH ESPECIAL VIEW TO TRAUMATISMS.*

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BRAIN surgery is still in the hands of the general surgeon, assisted in diagnosis frequently by the neurologist, and while not in itself a specialty, calls, perhaps, for more special knowledge and skill than any other branch of general surgery. From the close anatomical proximity of the organs of special sense to the brain and the relation of their different pathologies to various brain lesions, the eye, ear, and nose specialists, in particular, find their operative work often concerned with the brain and its envelopes, and consequently must be familiar with the principles and technique of this subject. They should also be able to dissect the triangles of the neck in case of sinus thrombosis.

Brain surgery necessarily includes that of its bony capsule, the cranium, as well as its membranous and vascular envelopes, the meninges. The necessity for such surgery is essentially threefold: 1. The presence of new growths, either of the viscus itself, or its envelopes, constituting the elective class; 2. The various results of trauma, such as fractures, accompanied or followed by depressed bone, hæmorrhage (later cysts) and abscess or meningitis resulting from direct infection; 3. Metastatic processes from septic conditions in the skull or adjacent bony sinuses—the last two making up the emergent class.

In a general way the difficulties or limitations are: 1. The relative difficulty of access to this viscus compared with that of reaching the various organs and viscera in the three other chief cavities of the human body; 2. The great desirability, if not necessity, and the frequent difficulty, if not impossibility, of a precise pre-operative geographical diagnosis. In the thorax, abdomen and pelvis explorative operations are feasible without a pre-operative diagnosis, while within the skull they have usually been considered prohibitive, or at least of very doubtful expediency; 3. The fact, closely allied with the one just stated, that symptoms of brain lesions are not infrequently delayed, and even when manifest are often misleading, coupled with the other fact, that lesions in the so-called " silent regions " of the cerebrum, viz., the first and second frontal convolutions with most of the occipital region, generally give us no leading symptoms.

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The possibilities of improvement in brain surgery lie chiefly in a clearer knowledge of regional function, and its interpretation by symptoms—in other words, better diagnosis. For instance, Krause, of Berlin, by the use of local faradization, while exciting cortical centres in the human brain, in operations for Jacksonian epilepsy, has taught us that the motor area occupies not the ascending frontal and parietal convolutions, but the ascending frontal only; while the speech centre, instead of being single and located in Broca's convolution, is threefold, with as many anatomical distributions. Increasing use is also made of the ophthalmoscope to determine eye conditions having some bearing on brain lesions.

The work of Keen and Sir Victor Horsley have shown the possibility and expedience of removing or breaking back large bone areas for explorative purposes, when diagnosis is presumptive but not positive.

The tolerance of the brain itself to aseptic explorative puncture, incision, etc., is increasingly apparent.

In exploring for brain abscess the best instrument is the dull spatula-like knife of Horsley, which on being introduced and pressed slightly one way and the other allows more ready outflow of pus, where it exists, than does a director.

If pus appears, never withdraw the knife or director until a pair of forceps is passed down to the cavity and spread sufficiently to allow evacuation and subsequent passage of a drain, preferably a soft rubber tube or rubber tissue, as gauze does not drain pus but rather causes retention. If the exploring instrument be withdrawn before introducing a spreading forceps the location of an abscess may easily be lost, as the soft brain matter rolls in and obscures the explorative track.

The usual order of symptoms of brain abscess are headache, somnolence, deepening into stupor, slow pulse and moderate temperature variations, usually preceded by trauma of skull or disease of one of the bony sinuses. The headache, however, may be very transient, or the patient may be first seen in the stage of somnolence or coma, when the case may be confused with uræmia, continued fever, alcoholism, etc. The pulse may be rapid instead of slow and the temperature may run high.

Meningitis may be compared in the cranial cavity to extensive peritonitis in the peritoneal cavity, but offers less hopeful outlook to operative treatment, although drainage is sometimes, though rarely, successfully attempted.

Disease or injury in the motor areas offer the best opportunity for operative treatment when consciousness is not lost; but the surgeon should not forget that abscess or tumor in the "silent regions" may, by transmitted pressure, simulate motor area conditions, and so mislead attempts at geographical diagnosis. It may be noted, in passing, that lesions of the frontal lobe are not infrequently followed at a later period by changes of temperament or disposition.

Many have been the interpretations of pupillary changes, but it is now pretty generally held that while contraction, dilatation, inequality, etc., occur as the result of brain lesions we know practically nothing about the exact relationships. It probably is safe to assume this much, that a persistently irresponsive pupil indicates cerebral trouble.

Choked disc or "high-grade optic neuritis" is not a sign of much value in emergent or traumatic brain surgery, as it rarely exists in intracranial hæmorrhage or brain abscess. It is most characteristic of brain tumors.

Cheyne-Stokes breathing is a concomitant of the late stages of meningitis, being generally a precursor of death. Its cause is in dispute, but is probably due to alternating anæmia of the respiratory centre in the medulla.

In traumatic conditions of the brain, consciousness or unconsciousness, pulse rate, tension and temperature, and of course localizing symptoms, if conscious, are the most important factors in determining diagnosis, prognosis and plan of treatment. Of all these the temperature course is probably the best index of the severity of the lesion. It is considered important in unconscious cases to know whether or not there was even a brief interval of a few minutes or seconds of consciousness before stupor or coma began. It is pretty well recognized to-day, however, that long continuance of unconsciousness means either extensive pressure by depressed bone or blood clot, or else brain contusion. The form of contusion under consideration is really an organic injury of serious import, owing to disintegration of brain cells and consequent cerebral œdema, not dependent on pressure, and consequently not amenable to treatment by trephining, incision of dura, etc.

This water-logged condition, dependent on loss of cell vitality, is often overlooked, even at autopsy, unless accompanied by excess of serum in the ventricles and arachnoid space, but is none the less, when it exists, an almost invariable cause of death. We suspect this serious form of œdema in cases of prolonged stupor, rising and, *later,* irregular temperature, and should recognize the futility of operation for relief of presumed intracranial tension which either does not exist or else is incapable of relief, because the tension-producing element is not superficial, but intimately distributed throughout the brain substance.

CASE I.—A. V., aged ten months, fell a distance of about 8 feet—immediately unconscious. Two hours later I saw the child in consultation. Shock was profound; convulsions involving both right extremities, and afterwards the left as well; pupils somewhat unequal; pulse barely perceptible; surface cold and clammy. I declined to operate because of general condition and ignorance of the locality of lesion on account of the general and multiple symptoms. A tentative diagnosis of cerebral hæmorrhage with extensive clot formation, or, more probably, serious general contusion, was made. For many days the infant hovered between life and death, afterward developing spastic contractures of all extremities, and finally passed from my observation because of my absence from the city. At a period of about six weeks after the injury Dr. Starr saw the case and diagnosed cerebral hæmorrhage with clot formation, focal intensity over left motor region. A rapid trephining, with nearly a fatal termination, on the table was done, with escape of about 2 fluid drachms of serum, followed by disappearance of spastic contractions, the patient dying, however, five days later. This relief of spasm must be considered in the nature of a triumph for surgical intervention in spite of almost insuperable limitations and the final fatal result.

1. The question arises whether the infant's general condition would, at any time, have permitted successful (curative) operation. In my opinion it is very doubtful. 2. Diagnosis—A blood clot sufficiently large to cause such extensive and manifold symptoms should have resulted in a larger quantity of serum at operation. The theory of general contusion within involvement of vitality of a multitude of cells seems more probable, as it would account for the profound shock and numerous symptoms, without a large amount of free serum. In such a case operation at any time must have failed.

Case II.—T. H., aged twenty-five, alighted, at night, carelessly from a moving train; fell and sustained a scalp wound in the upper part of the forehead near the median line. A local physician decided that there was no injury to skull or brain and sewed up the wound which healed kindly. About two months afterwards the patient became erratic, complained of frontal headache and rapidly developed mania; family history on this point negative. Patient was an inmate of private sanitorium for mental diseases for about two years without improving. The family, then, on advice, consulted Dr. W. W. Keen of Philadelphia, who diagnosed probable fracture at site of injury with cyst due to hæmorrhage. Operation completely verified the diagnosis by the escape of more than an ounce of serum through the trephine opening, and full recovery of reason.

1. It is probable that immediate explorative incision of the scalp in the region of injury would have revealed a fracture, even though not depressed, and that trephining would have discovered hæmorrhage and permitted its control—thus saving this talented young man two years incarceration is an asylum.
2. Note the possibility of cure in such cases of hæmorrhage by removal of the pressure element as late as two years, with the probability of a still later limit.

Case III.—J. McM., aged twenty-seven; admitted to the City Hospital July 3, 1904, suffering with what was diagnosed by the interne staff as a simple scalp wound on the left side of forehead near hair line, produced by a blunt instrument; length of wound ⅝ of an inch. No involvement of bone discovered. An explorative scalp incision not made; wound closed by suture and patient returned to his home. Two days later sutures were removed at the out-patient department of the hospital; union apparently good.

Two weeks later he returned to the dispensary on account of a small abscess in the suture line, which was evacuated and for about ten days dressed in the out-patient department. Meanwhile, no other symptoms developed.

July 30, an ambulance call was sent in for this patient, and he was removed to the hospital, where he remained until his death.

His history, on admission, presented nothing of note until 11 A.M. of that day, when he became moody and refused to talk, in spite of which he ate a hearty dinner. After dinner he went to bed and slept until 6 P.M. On waking he would only mutter incoherently; his gait was unsteady. Upon arrival at hospital his mentality was somewhat better; gave an account of his injury and identified his assailant.

Next morning (July 31) when questioned, he always gave the same answer, namely: "424 Montgomery street"—his residence; some loss of power in right arm; in afternoon dragged right leg. Next day (August 1) right arm and leg completely paralyzed, together with right facial paralysis; choked disc in right eye; left eye normal; sensation normal. At this time his answer to all questions was " McManus "—his name.

Diagnosis, cerebral abscess in left motor area. Operation advised but refused by relatives, who later, however, consented. Operation performed August 5; patient's condition stuporous, temperature 99.2°; pulse 84; respiration 24.

Usual scalp and bone incisions were made over the line of the fissure of Rolando, the bony opening measuring 2 inches by 1½. The brain pulsated; the dura appeared normal, and without tension. Our belief in the existence of an abscess, however, was so strong that the dura was incised and the brain substance in the underlying motor area explored in various directions by means of a good sized director. No pus found. Much to our surprise, however, on the following day the paralysis disappeared, showing that the operation had relieved tension that had not been appreciable to either sight or touch.

Improvement continued for about one week when paralysis and aphasia returned in the same order as on their first appearance. The general condition, meanwhile, became alarming. It then occurred to me to trephine over the site of injury, in spite of all symptoms pointing to the motor region. The patient's low general condition and the fact that his death would transform the case into one of murder, made me hesitate lest the defense would charge the result on the surgeon instead of the assailant. However, I reopened the wound without anæsthesia, and again used the director without result. Then I decided to take the desperate risk of trephining over the point of injury, ordering preparations for the following morning, but death intervened at 5 A.M.

Autopsy showed no appreciable fracture of the skull, but a small area of adhesion between the dura and cranium, about the size of a silver dime, just beneath the site of injury, also a corresponding adhesion between the meninges and cortex. The convolutions in this neighborhood were prominent, and on incision an abscess containing about 2 ounces of pus was revealed. The abscess was entirely in the frontal lobe but extended well backward and downward toward the motor area. There was evidence of a recent small abscess under the scar of the original scalp wound, a thin layer of purulent material intervening between the scalp and skull.

1. In spite of the non-existence of macroscopic fracture or even fissure, there was in this case transmitted infection, possibly by an emissary vein.

2. Evidence of brain pressure at some interval after skull traumatism is ground for suspecting brain abscess.

3. Pronounced motor symptoms do not necessarily mean that the lesion is in the motor area; they may mean transmitted pressure.

4. A marked peculiarity was that the aphasia was not motor, for he articulated words, but was nearly completely amnesic, for he only remembered his name and address, yet the centres for memory of words and objects are farther from the lesion in this case than the centre for motor aphasia, which exists in the posterior part of the third frontal convolution, the others being in or near the angular gyrus. This must be explained probably by the existence of the association fibres and their probable implication.

5. The presence of brain pulsation and absence of appreciable tension are not always reliable evidence of the absence of abscess or tumor.

6. The choked disc and facial paralysis, as well as the arm and leg paralysis, were on the side of the body opposite to the lesion—a rare occurrence. This may be explained by the action of the commissurial fibres.

7. The chief lesson of this case is that paralysis or hemiplegia in a septic traumatic case may mislead one into operating over the motor area, where no lesion may be found. Conversely, always trephine under such circumstances immediately at the site of injury, as the whole trouble may be there.

Case IV.—T. S., aged forty-eight, transferred to City Hospital from another hospital. He was suffering from alcoholism together with a scalp wound over the right parietal eminence. The wound had turned up a more or less semi-lunar flap, including periosteum, leaving bare a bone surface approximately the size of a silver half dollar.

The patient had been several days in the hospital from which he had been transferred, and the sutures (if any had been introduced) had either been removed or had cut themselves out, leaving the forementioned exposure of the skull. Examination of this bare area showed no irregularity or sign of injury, unless a mere hair line without depression could be interpreted as a fissure. There was no paralysis and no disturbance of mentality, except such periods of mild restlessness and excitement as are common to alcoholism, for which condition he was placed under treatment. The scalp wound was cleaned up and an antiseptic dressing applied.

This condition lasted about a week, at the end of which time I was absent from the city for a few days. On my return I found that the patient had died. He had suddenly developed left-sided twitchings, rapidly followed by paralysis, on the appearance of which my house surgeon had immediately trephined over the hair-like line on his skull, finding an abscess containing about one ounce of pus. The patient rapidly grew worse and died about forty-eight hours after operation.

Autopsy revealed an abscess cavity under the exposed bone, and also a quite extensive suppurative meningitis, involving the surrounding convolutions.

1. One should always question every suspicious mark on an exposed skull surface in case of traumatism, even if it be no more than a hair line, for this may be a possible fissure and a potential source of infection.
2. Do not pass lightly any evidence of disturbed mentality, such as alcoholism, in the presence of skull traumatism; it may mean either meningitis or abscess; and remember that alcoholism, *per se,* has a sub-normal temperature, while meningitis and brain abscess show temperature elevation.

CASE V.—John A., aged twenty-nine; arrested October 29, 1906, and locked up at the station house as drunk and disorderly. He complained of headache during the night, and was found unconscious in his cell the next morning. Sent to the City Hospital.

Conditions on Admission.—Unconscious; temperature 99°, rectal, pulse very high tension, and slow; respiration 16. A superficial brush wound over the left malar bone; a contusion of the right posterior vault of the cranium near parieto-occipital junction, and three dime-sized spots of ecchymosis on the left arm were all the external evidences of injury to be found. Pupils normal and responsive to light; no paralysis, but slight hypertonicity of muscles. Four ounces of urine obtained by catheter, dark amber, highly acid, sp. gr. 1020; sugar, casts and blood, negative; urea not estimated.

Treatment.—Head shaved and ice cap applied; calomel gr. v and jalap gr. xx administered by mouth; croton oil minims ii and olive oil, one pint, given as a high enæma; pilocarpine, gr. 1/10, hypodermatically, repeated in one hour.

Twelve M., temperature 98.8°; pulse 60, tension lessened; respiration 18; skin moist and warm, free action of bowels; pupils still normal; muscle tonus increased.

Two P.M. Patient yet unconscious, passing bright red blood from bowels; specular examination revealed no source of hæmorrhage; enæma of 1½ ounces. Adrenaline, 1/1000, in one pint of cold saline was given and an ice cap applied to the abdomen without effect; also an enæma of 2 ounces of bismuth subnitrate in a pint of cold saline, with negative result.

Six P.M. Muscle tonus minus; hæmorrhage continuing; temperature 99°; pulse 85 and soft; respiration 20.

Hæmorrhages continued and general condition of collapse deepened until death occurred at 1.25 A.M. the day following his admission.

Post-mortem Findings.—External evidences of injury as already noted. On dissecting up the scalp the right temporal muscle was found infiltrated with blood and a line of fracture 4 inches long was revealed, extending from the right parietal eminence downward and forward to the petrous portion of the right temporal bone, without elevation or depression.

Removal of the calvarium exposed a blood clot 3½ inches in diameter and 1 inch thick at its centre (amounting to about 2½ cubic inches), the posterior branch of the middle meningeal artery having been divided where it crossed the line of fracture. A corresponding depression in the cortex, extended from the margin of the posterior ascending parietal convolution to the cuneus and from the base of the skull to a point 1 inch below the longitudinal fissure.

Opening the abdomen the omentum and peritoneum were found dry and the intestines empty. The large intestine contained unclotted blood throughout its whole length, but no point of ulceration or erosion could be found. The mucosa was injected, blood-stained and showed small spots of submucous hæmorrhage. The liver indicated beginning fatty cirrhosis. Spleen normal. The kidneys were of normal size, capsule stripping easily. The cortex was slightly congested but no pathological condition was evident to inspection. Bladder contained about 8 ounces of urine. Heart and lungs normal. No microscopical examination of kidney tissue was made, consequently the possibility of nephritis was not definitely settled.

1. Here was a case where the different elements of a possible brain traumatism of a serious type, uræmia, or simple alcoholism presented upon admission.
2. The coma would be common to all; but at the time of admission. if due to alcoholism, should have been disappearing. In either of the other conditions it would likely be increasing.
3. Pulse rate and tension might be the same in either brain traumatism or uræmia.
4. Scanty secretion of a highly albuminous urine, together with coma and a high tension pulse, were very suggestive of uræmia, which we are not even now certain did not play a part, because no microscopical examination of the kidneys was made owing to lack of suitable facilities at hospital.
5. There was no external evidence of fractured skull.
6. The clot, although over some parts of the motor area, did not give motor symptoms, because of the existing coma.
7. Had a *local* scalp explorative incision been made no fracture would have been discovered.
8. Had an *extensive* scalp exploration been made the fracture would have been discovered. Trephining and control of hæmorrhage would then have transpired.
9. It is still an open question whether or not this procedure would have saved life. The patient evidently bled to death from intestinal hæmorrhage.

10. The vital question is what caused the continuous and fatal hæmorrhage?

11. Undoubtedly increased tension was an etiologic factor; but was the tension due to brain pressure or nephritis, or in either event would the increased tension for twelve to fifteen hours, have caused hæmorrhage in the normal intestinal mucosa?

12. If early operation is desirable to control hæmorrhage due to fracture of the cranial vault, this case certainly demonstrates the value of *wide explorative incisions and dissection of the scalp.*

Inasmuch as the fracture was not depressed but simply linear and did not approach the point of contusion nearer than 2 inches, nothing less than the reflection of a large flap of scalp would have revealed it. Such a procedure, if aseptic, should be safe, and if findings are negative the patient should be none the worse, while if positive much might be gained.